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June 19, 1998

Office of Pollution Prevention and Toxics (OPPT)
Document Control Office (7407)
Room G-099
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

RE: Document Control Number OPPTS-42187A; FRL-4869-1; Comments on the EPA Proposed Test Rule for Hazardous Air Pollutants

Dear Sirs and Ladies:

The Aluminum Association is pleased to submit the following comments on EPA's Proposed Test Rule for Hazardous Air Pollutants announced initially in the Federal Register on June 26, 1996 (61 Fed. Reg. 33178). The Aluminum Association is a trade association founded in 1933 and is comprised of 56 members in the U.S. aluminum industry, many of whom would be potentially impacted by the testing requirements in the proposed rule for hydrogen fluoride (HF) and carbonyl sulfide (COS).

These comments address a number of issues included in the proposed test rule for HF and COS testing requirements and applicability, the "impurity" exemption for testing applicability EPA has rescinded, and the issue of the one percent concentration cut-off applicability. We hope that these comments are useful in developing a final test rule for hazardous air pollutants. Please contact my office (202/862-5132) for any further information.

Sincerely,

Robert P. Strieter
Director, Environmental Affairs

xc: M.B. Meyer
Baker & Hostetler

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Comments of the Aluminum Association
on the EPA Proposed Test Rule for Hazardous Air Pollutants
40 CFR Part 799
(Document Control Number OPPTS-42187A; FRL-4869-1)
--- June 19, 1998 ---

The Aluminum Association submits these comments in response to the EPA proposed test rule for Hazardous Air Pollutants (HAPs) under section 4(a) of the Toxic Substances Control Act (TSCA), as published in the Federal Register on June 26, 1996 (61 Fed. Reg. 33178), and as re-proposed in the Federal Register on December 24, 1997 (62 Fed. Reg. 67469) . These comments focus on the proposed testing requirements for two of the listed HAPS included in the proposal, namely hydrogen fluoride (CAS No. 7664-39-3, herein referred to as HF) and carbonyl sulfide (CAS No. 463-58-1, herein referred to as COS), and the applicability of testing for those compounds on Aluminum Association members. The Aluminum Association is a trade association founded in 1933 and is comprised of 56 members in the U.S. aluminum industry. The proposed testing requirements for HF and perhaps COS could potentially have an impact upon many of our members operating primary aluminum reduction plants.

In summary, the Aluminum Association position on the proposed and revised proposal for TSCA testing is as follows:

1. EPA should include in its final determination that the HF Enforceable Consent Agreement (ECA) for toxicity testing previously announced in the Federal

Register on March 27, 1998 (63 Fed. Reg. 14869) will satisfy all of the relevant toxicity information necessary for HF;

2. EPA should delete from the revised proposal the provision that eliminates the "impurity exemption" for TSCA testing, and retain a distinction between byproduct and impurity producers of a chemical for testing applicability;

3. EPA should clarify the one percent concentration cut-off applicability for impurities, byproducts and other components because the proposed language is ambiguous. In this regard, we support the one percent exemption for listed chemicals, regardless of whether or not they are present as byproducts, impurities, or components. Such exemption conforms with existing statutory definitions as to what is regulated as hazardous (e.g. OSHA Hazard Communication Standard);

4. EPA's position to expand testing requirements beyond TRI reporting industries is well founded and should be preserved in the final rule;

5. EPA should rescind testing requirements for COS in the final rule because EPA has not met the TSCA Section 4 requirements for testing of COS, in terms of the need to demonstrate unreasonable risk from COS, to

demonstrate significant exposures, and to demonstrate that the existing database is insufficient to adequately predict the effects of COS on human health;

6. In the event that the Agency retains COS testing and impurity generator applicability in the final rule, the Agency must first establish a comprehensive emission inventory of COS emitters in order to establish all parties included in allocating testing costs; and

7. EPA should, at a minimum, postpone testing requirements for COS pending the conclusion of the National Toxicology Program COS testing program to determine if data gaps still exist.

Finally, the Aluminum Association supports the comments submitted by the Chemical Manufacturers Association Carbonyl Sulfide Panel in response to the COS toxicity testing proposals .

1. Hydrogen Fluoride

Primary aluminum producers are a by-product generator of HF. As a result, the Aluminum Association has been involved with the CMA HF Panel,

EPA and others in reviewing the Enforceable Consent Agreement (ECA) for HF toxicity testing. At the EPA sponsored public meeting on the HF ECA conducted at EPA headquarters in Washington, D.C. on February 5, 1998, and in subsequent technical sessions, an agreement was reached for an HF toxicity testing program, including the following study elements:

Acute neurotoxicity;

Subchronic inhalation;

Subchronic neurotoxicity;

Physiologically-based pharmacokinetic modeling studies; and

Portal of entry effects.

The Aluminum Association believes that the toxicological studies included in the HF ECA testing program address the necessary toxicity information EPA needs, and recommends that EPA revise the TSCA final rule to endorse the HF ECA program as the basis for testing requirements instead of the HF studies included in the proposed rule. An outline of the testing program is included in these comments as Attachment 1.

The attached testing program for HF relies on PBPK modeling to derive acceptable exposure levels for HF. The proposed testing would reduce the

burden for HF testing compared to the EPA proposed program, which would cost on the order of two to three million dollars or more. As a by-product generator of HF, the members of the Aluminum Association believe that the proposed HF ECA will adequately assess the effects of low level HF chronic exposures, as well as potential acute exposure effects.

For the record, U.S. aluminum reduction plants emit low levels of HF resulting in maximum exposure levels to surrounding areas below 10 ppb. Aluminum reduction plants do not emit liquid forms of HF, and have no potential for large acute exposure releases of any form of HF. Our assessment of low level HF exposures entitled "Fluoride Emissions and Human Health" as prepared for the Aluminum Company of America by Jonathan Borak, M.D. - Associate Clinical Professor of Internal Medicine at Yale University, and provided to the Aluminum Association, is included as Attachment 2 to these comments.

Dr. Borak's study concludes that available data suggest low level chronic HF exposures below 10 ppb will have no significant health effect consequences. We anticipate that the HF ECA toxicity testing program will add verification to that conclusion as well as derive a level of exposure for establishing a Reference Concentration (RfC). Currently available toxicity data may be less adequate for determining potential health effects from high concentration exposures and liquid

forms of HF releases, especially high acute exposures related to catastrophic releases. The HF ECA study will also address the potential significance level for acute exposures.

A. Physical Form of HF Emissions

Emissions of HF occur as either a colorless liquid or gas. Its physical form depends on ambient temperature and pressure. Below 67.1 degrees F, HF is a liquid at standard atmospheric pressure. At higher temperatures, it exists as a gas at standard atmospheric pressure. Emissions of HF also occur is an aqueous form known as hydrofluoric acid.

The exposure impacts of HF releases are a consequence of its physical form. HF gas is lighter than air and will disperse. However, large releases of HF in liquid form results in heavier-than-air particulates that can polymerize and carry downwind as a heavy aerosol. Rather than disperse, such HF aerosols tend to persist at high concentrations near ground level. This tendency to form dense, heavier-than-air aerosols leads to catastrophic hazards associated with liquid anhydrous releases.

As further described below, the potential biological effects of HF exposures are also determined by its physical form and by exposure dose. The potential adverse health effects of exposures to very low levels of HF are distinctly different than from exposures associated with high levels, especially exposure to liquid HF or hydrofluoric acid.

Because the compound is not stored or contained on site at primary aluminum facilities, there is no potential for large catastrophic releases of HF in aluminum reduction plants. Aluminum production involves an electrolytic process that converts aluminum oxide (alumina) to aluminum. This is a continuous process in large cells (termed "pots") involving alumina dissolved in a "bath" of aluminum fluoride and other compounds. Emissions of HF occur only as aluminum is formed in the reduction pots, as a continuous release, and liquid forms of HF never occur in aluminum reduction plants. As a result, heavier-than-air aerosols do not occur from those operations.

B. HF Exposure Levels Around Aluminum Reduction Plants

Exposures of HF in adjacent areas surrounding aluminum plants are well below 10 parts per billion (ppb), and almost always below 5 ppb. EPA has concluded in the past that exposure levels below 10 ppb have "no demonstrated

impact upon public health for the purposes of section 111(d)." [1] The report estimated that, in the 1970's, 8 micrograms per cubic meter (9.7 ppb) was the maximum concentration of exposure likely in the vicinity of a primary aluminum plant containing "moderate" control equipment. Since the 1970's, additional HF reductions have taken place with the installation of dry alumina scrubbers at many facilities. Now, EPA has promulgated a technology-based control mandate under section 112(d) of the Clean Air Act (CAA) which will necessitate all U.S. aluminum reduction plants to meet maximum achievable control technology (MACT) requirements for HF emissions, among other HAPs.[2] These standards will insure that HF emissions from primary reduction plants nationwide result in exposure levels to surrounding localities that are substantially below the 5 to 10 ppb range.

C. Health Effect Evidence from Low Level HF Exposures

As outlined in the appended report from Dr. Jonathan Borak, and as previously concluded by EPA, available data indicate that low level exposures to HF below 10 ppb will not likely pose significant human health effects. The

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[1] EPA report "Primary Aluminum: Guidelines for Control of Fluoride Emissions from Existing Primary Aluminum Plants." December 1979.

appended report by Dr. Borak includes a comprehensive review of available health effect studies of HF. Included in the assessment are data sources from the National Academy of Sciences Report of Fluorides, Toxline, ATSDR Toxicological Profile, USPHS Review of Fluoride, IPCS Environmental Health Criteria, and Patty's Industrial Hygiene and Toxicology data set. The review addressed information on systemic and non-systemic effects of HF.

For systemic effects, the report addressed information on toxicity to target organs from systemic absorption of fluoride, including renal effects, immunologic effects, reproductive and developmental effects, genotoxicity and carcinogenicity. As outlined in the report, available data supports the conclusion that low level chronic HF exposures below 10 ppb are not significant in causing or contributing to systemic health effects. This lack of significant effects from low level exposures is true for the reproductive, neurotoxicity, immunotoxicity and respiratory sensory irritation endpoints.

Similarly, non-systemic health effects were reviewed for respiratory, skin, and ocular toxicity. The effects found occur only at high HF concentrations associated with acute exposures many orders of magnitude above 10 ppb levels, and often are associated only with exposure to liquid or aerosol forms of HF. No

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[2] EPA final rule "National Emission Standards for Hazardous Air Pollutants for Source

effects were relevant to low level exposures below 10 ppb, and information is also noted in the report where there have been no observed effects from low level exposure studies.

In summary, EPA should acknowledge in the final test rule for HAPs that available data supports conclusions that low level airborne exposures to HF below 10 ppb are not likely to pose significant adverse health effects. The proposed HF ECA will adequately address remaining data gaps in determining the HF reference concentration for residual risk determinations.

2. Retention of the Impurity Exemption

EPA has determined in previous rulemaking for TSCA testing not to include "impurity" generators in testing applicability, including the June 15, 1988 hazardous waste test rule (53 Fed. Reg. 22300). The re-proposal of December 24, 1997 includes provision to rescind the impurity exception, and is a significant departure from the previous EPA policy in this regard. As such, the re-proposal would remove any distinction between by-product and impurities and subject all impurity producers to testing requirements provided specific production and concentration limits are met. This will significantly expand the complexity of

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Categories: Primary Aluminum Reduction Plants" (CFR Part 63, Subpart LL), (62 Fed. Reg.

developing a consent agreement and the assessment of test rule compliance costs.

The need to include impurity generators under the TSCA section proposed HAP test rule has not been justified. The difficulty of identifying low concentrations of impurities and the limited potential for significant exposure from impurity related releases suggests that the exemption should be retained for the HAP test rule as in past TSCA rulemakings rather than eliminated. At the very least, EPA should make available any justification for this significant policy change, if any, and request further comment before finalizing the impurity exemption provision for the HAP testing rule.

3. Clarification of the One Percent Concentration Cut-off

EPA includes in the re-proposal of December 24, 1997, provision for throughput and concentration thresholds in determining testing applicability. "Clarifying" language was also released by EPA in the Federal Register clarification statements of February 5, 1998 (63 Fed. Reg. 5915) and April 21, 1998 (63 Fed. Reg. 19694). The wording of these provisions is exceedingly

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52384, October 7, 1997).

difficult to assess and prone to misinterpretation. Our reading of these provisions, as best we can deduce the language, is as follows:

1. Producers of a test chemical as a discrete substance (not a mixture) are subject to test requirements if, during the last complete fiscal year, they manufacture the substance (including by-products and impurities as "manufacture") at a facility in a quantity of at least 25,000 pounds.

2. Producers of a test substance as a component of another substance or mixture are subject to testing requirements if the test substance is (a) manufactured (including by-products and impurities) at a facility in a quantity of at least 25,000 pounds; and (b) the substance is known to be present as a component of another substance or mixture at levels of at least one percent by weight (i.e. there is a one percent *de minimis* concentration). Therefore, streams where the substance of concern exists in quantities less than one percent by weight are not counted towards the 25,000 pound testing threshold.[3]

[3] EPA states in the April 21, 1998 Federal Register notice that "a chemical substance specified in Table 1 that is manufactured(including imported) as a component of another chemical substance or mixture in which the proportion of the substance specified in Table 1 is less than one percent by weight is not to be taken into account in determining whether the 25,000 lbs threshold specified in this paragraph has been met. (63 Fed. Reg. 19694 at 19699)

3. However, EPA may include otherwise exempted facilities if no one else is available to conduct the testing.

EPA has not clarified the new language with regard to the concentration exemption for testing applicability. As a result, the language, both in the re-proposal, and in the Federal Register clarification statement of February 5, 1998 (63 Fed. Reg. 5915) and April 21, 1998 (63 Fed. Reg. 19694) is not adequate to fully determine this provision. We recommend EPA confirm in the final rule that the concentration-based threshold applies to all components of products, mixtures, processes streams (including byproducts and impurities if not otherwise exempted from the test rule). In particular, EPA should clarify that a listed HAP to be tested under TSCA that is part of a complex stream or mixture of combustion gases (regardless of product, byproduct, or impurity) at a concentration of less than one percent by weight of the combustion gases shall not be counted in determining whether the volume-based testing threshold is met.

4. TRI as a basis for TSCA Testing Participation

In the re-proposal of December 24, 1997, EPA acknowledges that reliance solely on SARA section 313 TRI reporting as a basis for determining

what individual sectors must participate would be inappropriate. Reporting under SARA TRI is not likely to include numerous sources of HAPs, since only facilities in certain manufacturing SIC codes are required to report. For example, SARA does not include reporting from large utility companies. Therefore, potentially large sources contributing to significant exposure of HAPs may be left out of the test plan.

In addition, the sole use of SARA data would be inappropriate because it does not take into consideration the emission characteristics nor the significance of exposures from the reporting sources. As a result, companies that are insignificant sources of pollutant exposures would be inappropriately subject to significant resource allocations for toxicity testing requirements. The Aluminum Association recommends that EPA retain in the final rule the position in the re-proposed rule to use other available data in addition to SARA reports to develop an applicability determination in the HAP testing program.

5. Carbonyl Sulfide

The Aluminum Association supports the comments of the Chemical Manufacturers Association (CMA) Carbonyl Sulfide Panel with regard to EPA's proposed COS testing and the recommended testing requirements. In addition,

the Aluminum Association opposes the imposition of COS testing requirements on aluminum primary producers, because these COS emissions are solely the result of sulfur impurities in the components of the aluminum production process. The formation of COS in aluminum production results as an impurity and not as a byproduct of the process. Although EPA has retracted the impurity exception from this rulemaking, we recommend, as addressed above, that the impurity exemption be retained in the final rule, leading to COS testing only on manufacturer's and by-product generators.

A. Support for the CMA - COS Panel Comments

The CMA COS Panel is submitting comments on the proposed rule with respect to the proposed COS testing provisions. Those comments include support for the following major positions:

1. EPA has not met the TSCA Section 4 requirements for testing of COS, both in terms of the need to demonstrate unreasonable risk from COS and to demonstrate significant exposures.

2. The existing health effects data for COS are sufficient to determine or predict adequately the effects of COS, and no additional testing is necessary.

3. Based on the use of the TRI data-base to assess testing participation, most sources of COS would not be subject to the testing requirements due to non-reporting under SARA. In fact, the contribution of COS by TRI reporting industries is inconsequential compared to the natural background sources.

The Aluminum Association supports the positions of the CMA COS panel, and believes that COS should be deleted in the final rule. Indeed, given the low toxicity of COS, as outlined in the COS Panel comments, EPA should initiate consideration of delisting COS as a hazardous air pollutant under section 112(b)(3)(C) of the revised Clean Air Act. Any further testing of COS toxicity should be aimed at a determination for delisting under section 112(b).

B. COS as an Impurity in Aluminum Production Operations

The proposed rule initially included provision to exempt "those manufacturers and processors that produce the chemical substances listed above only as an impurity, as defined in 40 CFR 790.3" including COS.[4] However, re-proposal of the rule eliminated this exemption. Never-the-less, the Aluminum Association supports the originally proposed provision, and its

[4] Proposed rule preamble, 61 Federal Register 33178, at 33189 and 33190.

applicability to the COS testing if retained in the final rule. As such, we would interpret the impurity exemption provision to exclude aluminum producers from COS testing requirements, since COS is an impurity to the aluminum reduction process.

The electrolytic process for primary production of aluminum involves the use of carbonaceous anodes made from the processing of coal tar pitch and petroleum coke. A contaminant in the pitch and coke includes sulfur compounds, which remain as an impurity to the final anode in the aluminum production process. During the electrolytic reduction process, sulfur contaminants form chemically with carbon and oxygen to produce COS.

The presence of COS in the aluminum production process is undesired. It is not formed as a necessary secondary reaction, or produced as an intermediate in the alumina reduction process. Nor is COS helpful in improving reaction rates or efficiency in aluminum production. The presence of sulfur in the anode is, in fact, an unwanted contaminant that reduces the anode efficiency and thereby lowers productivity of the operation. At the present time there is no economical or feasible means to remove the sulfur contaminants in the pitch and coke components in forming anode material. The formation of COS is, therefore, an undesired contaminant to the aluminum reduction process.

As an undesired contaminant in the process, COS is defined as an impurity under TSCA section 4 testing provisions.[5] In this regard, aluminum producers are exempt from any testing requirements for COS, as outlined in the proposed rule. The Aluminum Association supports retention of EPA's proposed impurity exemption in the final rule, including its relevance to the COS testing if retained in the final rule.

C. COS Exposures From Aluminum Operations

Emissions from primary aluminum operations result in low levels of exposure, typically below 0.5 ppm. The generation of COS is on a continual basis as the anode material in the reduction pots is consumed during the production of aluminum. There is no potential for a large emission release at any time due to a process upset, and there is no catastrophic release potential since COS is not stored or contained on-site. As a result, no significant exposure spikes or acute exposures can occur in areas proximate to aluminum operations.[6] Therefore, the impacts of high level chronic exposures to COS, or

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[5] See definition of "impurity" under 40 CFR 790.3 Definitions.

[6] EPA did not regulate COS in the recent National Emission Standards for Hazardous Air Pollutants for Primary Aluminum Reduction Plants (also referred to as the Primary Aluminum Maximum Achievable Control Technology (MACT) requirements). 62 Fed. Reg. 52384, October 7, 1997. Primary Aluminum Production MACT regulations focused instead on Hydrogen Fluoride and Polycyclic Organic Matter (POM) emissions.

long term consequences from acute or catastrophic releases of COS, are not a possibility from aluminum operations.

6. COS Emission Inventory Determination

In the event EPA retains the unfortunate provisions of both COS testing and inclusion of impurity generators in the final rule, testing for COS cannot be initiated until EPA conducts a thorough emission inventory for the compound. Current information for COS emissions is very limited and potentially conflicting. Anthropogenic sources of COS are not well documented. Sources not reporting under the TRI are even less well known with respect to COS emissions. In order to develop a fair system for allocating testing costs, EPA should first develop a COS emission inventory for review and comment. Without a comprehensive emission inventory, it is not possible to develop an equitable test allocation system for COS testing.

7. COS Testing by the National Toxicology Program

Included in the most recent National Toxicology Program (NTP) annual plan, the toxicological testing of COS has been approved.[7] Included is the NTP

[7] NTP, Fiscal Year 1997 Annual Plan, at pg 24.

proposed "short and long-term toxicity testing" for neurotoxicity, ototoxicity, and possibly carcinogenicity. Also currently under design are inhalation studies for carbon disulfide (CS), a COS metabolite. The planned COS toxicity studies, and CS pharmacokinetic studies, will provide much, if not all, of the remaining information needed to assess health risks from COS. Therefore, we recommend that EPA, at the very least, postpone COS testing requirements until the NTP program has been completed.

Summary

Aluminum Association concludes the following with respect to the proposed TSCA testing rule for HAPs:

- The aluminum production process is a low level emitter of HF, with exposures in adjacent localities below the 5 to 10 ppb range. No high exposure spikes or acute exposures are possible from aluminum operations. To provide supporting data on HF exposure effects, and to develop an RfC for residual risk determination, EPA should conclude in the final rule that the HF Enforceable Consent Agreement (ECA) for toxicity testing previously announced in the Federal Register on March 27, 1998 (63 Fed. Reg. 14869) will satisfy all of the relevant toxicity information necessary for HF.

- EPA should retain the impurity exemption in the final rule to continue the previous regulatory precedence under TSCA, making a distinction between byproduct and impurity producers of a chemical for testing applicability.

- EPA should conclude in the final rule that the one percent *de minimis* concentration threshold proposed exemption applies to streams and mixtures, including impurities (if not otherwise exempted in the rule) and byproducts and other components.

- The use of SARA section 313 TRI emissions reporting as a sole mechanism to determine participating companies in a HAP testing program is inappropriate, would omit important emitters of the pollutants of concern, and would lead to an arbitrary allocation of testing requirements on reporting companies that are actually insignificant exposure sources of the HAP. We therefore support EPA's decision in the re-proposal to rely on other emission data in addition to SARA reporting as a mechanism for determining what sectors must participate in the test plan.

- The proposed large scale testing for COS is insupportable given the comments outlined by the CMA COS Panel regarding exposures and toxicity.

EPA has not made an adequate finding of unreasonable risk or significant exposures. Any testing that EPA determines is necessary for COS should be designed to address a potential delisting of the compound under section 112(b) of the Clean Air Act.

- A comprehensive emission inventory of COS emitters is necessary to address any COS toxicity testing program that includes impurity generators of COS.

- EPA, under any circumstances, should at least postpone development of a COS testing program pending completion and results of the NTP testing program under development.

Attachment 1
Outline of HF Consent Agreement Toxicity Testing

Acute Neurotoxicity

- In conjunction with the 90-day subchronic inhalation study, an acute neurotoxicity study will be undertaken. After the first exposure in the subchronic study, a select number of rats will be assessed for functional observation battery (FOB) and motor activity (MA) parameters. Neuropathological evaluation will be conducted based on the outcome of the subchronic neurotoxicity study.

Subchronic Inhalation

- Exposures will be on male and female rats 6 hours per day, 5 days per week for 13 weeks. There will be 4 exposure groups.

- Expected exposure concentrations will be in the range of 0.1 to 1 ppm, 5 to 10 ppm and 10 to 50 ppm.

- At approximately test day 45 and then near the end of the study (day 90), a select number of rats will undergo clinical pathological evaluations.

- After the first exposure, a satellite group of rats will be removed from the study. Multiple blood samples for fluoride levels will be collected from this satellite group of rats after the first exposure, then daily for 5 days. Urine will also be collected at 12, 24, 48, 72, 96 and 120 hours and analyzed for fluoride levels. Tissue fluoride levels will be determined at the end of the 5-day period.

- After exposure days 1, 7, 28 and 90, a select number of rats will be sacrificed for detailed histological mapping of the nasal cavity according to the method of Mery et al. (1994) Blood will be collected from sacrificed rats for blood fluoride levels.

- The nasal cavity will be evaluated by the method of Mery et al. (1994). At least 10 sections will be evaluated and lesions mapped. These data will be used to estimate regional flux from computational fluid dynamic (CFD) models described by Kimbell et al. (1997).

- After the first exposure, a select number of rats will undergo bronchioalveolar lavage (BAL) for macrophage functionality.

- At the end of the 90-day phase, all tissues will be taken to wet stage. Liver, respiratory tract (excluding the nasal cavity), spleen, brain, kidney, and heart will be evaluated microscopically.

- Near the end of the study, a select number of rats will undergo immunotoxicity evaluation using the sheep red blood cell (SRBC) assay.

Subchronic Neurotoxicity

- Male and female rats will be administered sodium fluoride via the diet for at least 90 days. FOB and MA assessments will be conducted at 4, 8 and 13 weeks after initiation of the study.

- There will be four treatment groups; a control and three exposure groups. The dosage of sodium fluoride will be determined based on assessment of available literature or a pilot study.

- Periodically, blood will be collected from a satellite group of rats for determination of blood fluoride levels at days 1, 7, 28, 60 and 90.

- At the end of the study, the animals will be sacrificed for neuropathological evaluation.

Physiologically-Based (PB) Pharmacokinetic Model (PK)

- A group of rats will be given once, by gavage, sodium fluoride; there will be two dose groups and a control group. Another group of rats will be administered sodium fluoride for 5 consecutive days; there will be two dose groups and a control group. Dose levels will be determined from available literature or a pilot study.

- Blood will be collected for 5 days with multiple collections on the first day, then daily for 5 days after the last dose of sodium fluoride. Urine will be collected at 12, 24, 48, 72, 96 and 120 hours after administration for fluoride levels. At termination, select tissues will be collected for residual fluoride levels.

- From these data, classical PK parameters, e.g. half-life, clearance, volume of distribution, etc., will be determined.

- Groups of rabbits will be administered a single dose, by gavage, of sodium fluoride; there will be two dose groups and a control group.

- Blood and urine will be collected as described above for the rat.

- A group of rabbits will be exposed once to HF by inhalation for 6 hours. The exposure concentration may be in the range of 20 to 50 ppm. Blood and urine will be collected as previously described for the rat.

- From these data, classical PK parameters will be determined.

- Bioavailability studies of fluoride also will be conducted following intravenous administration of sodium fluoride, and gavage of sodium fluoride dissolved in water and mixed in a dietary slurry.

- From the available literature for various physiological data, the PBPK model for both rat and rabbit will be constructed and then extended to human.

Portal-of-Entry Effects

- From the detailed mapping of histological lesions of the nasal cavity, a CFD model will be constructed and the flux determined. This model will be constructed according to methods described by Kimbell et al. (1997).

- The CFD model will then be extended to the human.

Attachment 2

Fluoride Emissions and Human Health

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Yale University

JONATHAN BORAK & COMPANY, INC.

Specialists in Occupational & Environmental Health

FLUORIDE EMISSIONS and HUMAN HEALTH

May 7, 1996

Prepared for:
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In its Basis and Purpose Document for the Development of Proposed Standards for the Primary Aluminum Industry (1), USEPA addresses proposed limitations on emissions of hydrogen fluoride (HF) from primary aluminum production plants:

- "The proposed MACT standard for primary aluminum plants limits emissions of hazardous air pollutants (HAPs), primarily hydrogen fluoride (HF) and polycyclic organic matter (POM)";
- "HF, one of the major HAPs of concern, is generated from the fluoride compounds used in aluminum production";
- "HF and POM are the major HAPs emitted from the anode bake furnace stack".

The following discussion considers the significance and scope of HF release in this context and whether there are any adverse human health effects that might be anticipated from such emissions.

I. About HF and HF Emissions

Hydrogen fluoride is a widely used industrial chemical valued for its great acidity. For most industrial purposes it is manufactured by reacting sulfuric acid with fluorospar (calcium fluoride, CaF_2). It occurs naturally in the vapors of volcanoes, as a product of pyrolysis, and in the vapors and dusts released from industrial processes such as steel production, ceramic factories and aluminum reduction. It is this last category of HF occurrence that is the focus of the proposed MACT.

HF can be encountered as either a colorless liquid or gas. Its physical form depends on ambient temperature and pressure: under standard pressure and at temperatures below 19.5°C (67.1°F), it exists as a liquid. At higher temperatures, it exists as a gas. HF is also found as an aqueous solution of variable concentration known as hydrofluoric acid.

The consequences of an HF release are determined by its physical form. HF gas is lighter than air (Vapor Density of 0.69). Hence, released gas tends to rise and disperse. But when anhydrous liquid HF is released, it tends to polymerize, forming heavier-than-air particulates that carry downwind as a heavy aerosol (2). Rather than undergoing quick dispersion, such HF aerosols tend to persist at high concentrations near ground level. This tendency to form dense, heavier-than-air aerosols leads to the catastrophic hazards associated with liquid anhydrous HF releases. HF also vaporizes from aqueous solutions: the partial pressure of its vapor over a 70% solution at 27°C is 150 mm Hg (3-5).

Likewise, the biological effects of exposure to HF are determined by its physical form and also by exposure dose. As described below, the adverse effects of exposure to very low air levels of HF are distinctly different from those associated with exposure to high levels. Similarly, there are enormous differences between the adverse effects caused by exposure to very low air levels of HF and those resulting from contact with liquid HF or hydrofluoric acid.

In the context of primary aluminum smelters, HF emissions result in very low ambient air levels <10 ppb. Such levels have little in common with the potentially catastrophic scenarios often feared and occasionally encountered as a consequence of the release of large quantities of anhydrous HF. Concern for such "worst-case releases" has led to listing of HF under CAAA 112[b][1], but such concerns are not justified at aluminum smelters or other sources of low level ambient HF. USEPA's 1990 Report to Congress which was mandated under CAAA 112[n][6], for example, reflects the realization that worst case anhydrous HF releases are not the same thing as is seen in airborne emissions from aluminum plants:

> "This report ... identifies and evaluates the hazards to the public posed by the production and use of HF. It is not intended to quantify risk to the public from HF. **Analysis of public exposure to routine emissions was not included in this study** because statutory language focuses on worst-case releases from accidents" (**emphasis added**) (7), *p.xiii*).

This view is consistent with previous EPA conclusions relating to aluminum plant emissions. When USEPA first proposed performance standards for the primary aluminum industry in 1974, the Agency acknowledged that airborne fluorides posed no hazards of adverse human health effects:

> "the Administrator relied heavily upon the report Fluorides, which was prepared for the Agency by the NAS in 1971 ... [which] concludes: 'Current knowledge indicates that

airborne fluoride presents no direct hazard to man, except in industrial exposure' ... present evidence indicates that fluorides in the range of ambient concentrations encountered under worst conditions do not damage human health through inhalation" (8) *p.xviii*).

The actual conclusions of that NAS study are still stronger:

"Severe effects of airborne fluoride on man ... have so far been observed only from long-term occupational exposures ... Only a few instances of health effects in man have been attributed to community airborne fluoride ... most of these reports addressed themselves to the incidence of nonspecific responses, such as hematologic changes and other indices of general state of health, which are not peculiar to fluoride and may reflect various other influences. In fact such effects have not been reported in the US, even in persons exposed occupationally to airborne fluoride if the concentrations have not exceeded the recommended industrial threshold limit values ... The other responses attributed to fluoride in man have been found mainly in relation to nonairborne fluorides. (9) *p.234-5*).

In other words, NAS found no adverse human health effects of airborne fluorides at levels below 3 ppm for HF, 2.5 mg/m^3 for particulate fluoride, and 0.1 ppm for fluorine gas. Thus, NAS determined that airborne HF was **not** associated with adverse human health effects at levels that were 1000 times greater than those anticipated (e.g., <10 ppb) near aluminum smelters.

II. Human Health Effects of Chronic Ambient HF Exposure

To ascertain whether those NAS conclusions remain valid, we performed a systematic search seeking more recent reports or data suggesting that the contemplated levels of HF exposure from aluminum production would cause adverse human health effects. That search was conducted using the following computerized database and four recent comprehensive reviews as sources:

1. TOXLINE: a comprehensive computerized database published and regularly updated by the National Library of Medicine listing citations and abstracts for reports and studies published in a large number of scientific journals;

2. ATSDR Toxicological Profile (10): a comprehensive review mandated by SARA (PL 99-499) and published in 1993 by DHHS following numerous peer reviews and a public comment period;

3. USPHS Review of Fluoride (11): "a comprehensive review and evaluation of the public health benefits and risks of fluoride in drinking water and other sources" published in 1991 by DHHS;

4. IPCS Environmental Health Criteria (12): a comprehensive monograph on the environmental impact of fluorine and fluorides published in 1984 under joint sponsorship of the United Nations Environment Programme, the International Labour Organization and the World Health Organization;

5. Patty's Industrial Hygiene and Toxicology (4): a six-

volume set of toxicology data regarded as the most comprehensive compilation of such data on individual chemicals, this particular section was published in 1994. As described below in detail, the evidence from the scientific literature published since the NAS report confirms that ambient exposure to low levels of HF does not cause adverse human health effects.

II.1 Non-Systemic Effects: Possible adverse health effects of ambient HF exposure that could occur independent of systemic absorption of fluoride include toxic effects to the respiratory tract, skin and eye.

II.1.a Respiratory Effects

Our literature search located no recent reports or data -- that is, dating from the time of the NAS review -- suggesting that the contemplated levels of HF exposure would cause adverse human respiratory effects. To the contrary, where more recent information is available it substantiates the earlier NAS/USEPA views:

- NIOSH described a study of workers exposed occupationally to HF at levels of 0.07-10 ppm (arithmetic mean of 1.03 ppm). Pulmonary function tests were normal in all workers and there were no statistical differences between exposed workers and matched controls (13);
- A study of children living downwind from an aluminum smelter found no association between proximity of residence to the smelter and either prevalence of respiratory symptoms or

results on standard pulmonary function tests (14);

- Two recent reports describe accidental releases of HF that affected populated communities and caused acute, adverse human health effects. In one, measured ambient levels one hour after release were >10 ppm and nearby car windows were etched (15) and in the other, ambient levels were estimated as >20 ppm (16). These reports are not relevant to chronic emissions contemplated in the Proposed Standards.

II.1.b Skin Effects

There are numerous reports of skin burns due to splash exposure to liquid HF and hydrofluoric acid, but our search located no recent reports or data suggesting that ambient HF exposure causes skin injury.

II.1.c Ocular Effects

There are various reports of eye burns due to splash exposure to liquid HF or hydrofluoric acid, but our literature search including a recent "encyclopedia" on ophthalmologic toxicity (17) located no reports or data suggesting that ambient HF exposure causes eye injury. To the contrary, there are older data in humans that only mild eye irritation resulted from exposure to 2-4 mg/m^3 (2.5-5 ppm) HF 6 hours/day X 10 days (18). Such exposures are about 1000 times greater than those anticipated near aluminum smelters.

II.2 Systemic Effects: Other possible adverse health effects of ambient HF exposure would require systemic absorption of fluoride leading to toxicity in target organ systems. As outlined below,

we found no evidence in the NAS review or since that report that ambient exposure to low levels of HF would cause such adverse human health effects.

II.2.b Renal Effects

Most studies have failed to find any association between chronic exposure to fluoride and renal toxicity. For example, WHO concludes that:

> "No renal disorder has been related to fluoride in areas of endemic fluorosis or to cases of industrial fluoride exposure. No cases of renal signs or symptoms are mentioned in connection with prolonged intake of fluoride in the treatment of osteoporosis and otospongioisis ... No indications of increased frequency of kidney diseases or disturbed kidney functions have been recognized in areas with water fluoride concentrations of 8 mg/L" (12), p.82).

USPHS reaches a nearly identical conclusion:

> "Several epidemiological investigations have found no human kidney disease from long-term nonoccupational exposure to fluoride concentrations in drinking water up to 8 mg/L" (11), p.65).

ATSDR also includes no reports of renal effects following exposures of the sort contemplated in the Proposed Standards.

By contrast, an older study (cited in the Proposed Standards) reported a NOAEL of 7 mg/m^3 (8.1 ppm) for renal toxicity in rats exposed for 6 hrs/day, 6 days/week for up to 30 days (19). Anticipated HF levels near aluminum smelters are more

than 5,000 times less than that NOAEL.

II.2.c Immunologic Effects

In 1971, at the request of the US Public Health Service, the American Academy of Allergy examined the literature on alleged allergic reactions to fluorides. The conclusions of that study were that there was no evidence of immunologically mediated reactions attributable to fluoride exposure and also no evidence of allergy or intolerance to fluorides (20).

Our literature search has located no recent reports or data suggesting that humans suffer immunologic effects due to elevated exposures to fluorides. The USPHS has summarized the available data as follows:

> "The literature contains minimal animal and human data on sodium fluoride related hypersensitivity reactions. In animals, investigators often used excessively high doses, inappropriate routes of administration, or both ... Reports of human hypersensitivity reactions ... are scattered and largely anecdotal" (11) p.69).

II.2.d Reproductive and Developmental Effects

There are essentially no data that increased parental exposure to fluoride results in human reproductive or developmental toxicity. Epidemiological studies found no difference in the rates of birth defects when the records of >200,000 babies born in an area with fluoridated water were compared to those of >1,000,000 babies born in areas with low water fluoride (21).

Although once an issue of concern, multiple recent studies have found no differences in the incidence of Down's Syndrome among residents of communities with and without fluoridated water (10-12). Regarding this issue, USEPA has concluded that "the current consensus is that fluoride has no influence on the incidence of Down's syndrome" (22).

In animals, bone morphology in fetuses was not affected by maternal fluoride doses of up to 21 mg/kg/day administered prior to mating and throughout pregnancy (23).

II.2.e Genotoxicity

Genotoxic effects have not been reported in humans exposed to HF or other fluorides (10,12). In *in vitro* models, very high levels of sodium fluoride (>20 μg/mL) caused genotoxic effects (unscheduled DNA synthesis and chromosome aberrations), but only at doses lethal to 40-50% of treated cells (24). More recent studies have confirmed that these effects occur only at concentrations that would be lethal to humans and animals (25,26). Thus, these findings are not relevant to concerns for genotoxicity at levels of exposure resulting from the routine emissions contemplated in the Proposed Standards.

II.2.f Carcinogenicity

There is no evidence that exposure to HF increases the risk of cancer in humans or animals (27). Numerous epidemiological studies have considered possible connections between fluoridated water and cancer. As summarized by ATSDR, "The weight of the

evidence indicates that no such connection exists" (10). Likewise, IARC concluded that "there is no evidence from epidemiological studies of an association between fluoride ingestion and human cancer mortality" (28). There are apparently no data on the relation between inhalation exposure to ambient fluorides and cancer in humans.

There is also little basis to contend that exposure to fluorides causes cancer in animals. In 1982, IARC determined that "the available data are inadequate for an evaluation of the carcinogenicity of sodium fluoride in experimental animals" (28). More recent NTP studies have not altered that determination (29). For example, there were no carcinogenic effects of chronic sodium fluoride exposure in females rats (4.74 mg/kg/day) nor in $B6C3F_1$ mice (17.8-19.9 mg/kg/day), and only equivocal evidence of an effect in male F344/N rats (29).

III. Health Effects of Ambient HF Cited in USEPA's Basis and Purpose Document

In its Basis and Purpose Document, USEPA's discussion of HF-related human health effects contains only four paragraphs (pages 11-12). For purposes of precision and clarity, the following discussion will consider that discussion on a paragraph-by-paragraph basis:

III.1 Paragraph #1: This paragraph addresses the health effects of exposure to anhydrous HF and highly concentrated HF solutions (i.e., hydrofluoric acid). It concludes with a statement that HF is highly reactive and "in many cases its

reaction products also are hazardous". The reference cited for that statement is USEPA's 1990 Report to Congress that was mandated under CAAA 112[n][6] (7). But, as indicated above, that report explicitly excludes ambient exposures:

> "This report ... identifies and evaluates the hazards to the public posed by the production and use of HF. It is not intended to quantify risk to the public from HF. **Analysis of public exposure to routine emissions was not included in this study** because statutory language focuses on worst-case releases from accidents" (**emphasis added**) ((7), *p.xiii*).

In other words, USEPA's statement in Paragraph #1 is not relevant to the routine emissions contemplated in the Proposed Standards. Moreover, our review of the scientific literature fails to find evidence that HF at the levels anticipated (e.g., <10 ppb) causes any of the human health effects described. Likewise, we find no evidence of "reaction products [that] also are hazardous" at those low levels.

III.2 **Paragraph #2**: This paragraph discusses health effects as summarized in ATSDR's Toxicological Profile (10). But, the Basis and Purpose ("B&P") Document has ignored various limitations of those cited studies and also fails to acknowledge specific concerns about them as noted by ATSDR.

For example, the B&P Document states that "animal tests have shown that exposure through inhalation for several months can result in damage to kidneys". But the actual facts presented in the ATSDR Profile describe a significantly different set of risks

and concerns than those described in the B&P Document. Following is a summary of the facts about renal effects as outlined by ATSDR:

- Renal cortex damage occurred in 27/30 rats exposed to HF at levels of 24 mg/m^3, 6 hrs/day, 6 days/week for up to 30 days, but not in rats exposed to 7 mg/m^3 (19);
- Renal damage was reported in rabbits and guinea pigs exposed under a variety of exposure conditions (30), but ATSDR notes that "the levels at which exposure-related effects were seen were not reported" (10). Review of the actual published research report indicates that HF exposure levels ranged from 0.024-8.0 mg/L (29-9784 ppm);
- Another study by the same authors found kidney damage in 4 rabbits and one monkey exposed to 0.0152 mg/L (18.6 ppm), 6-7 hrs/day for 50 days (31);
- ATSDR cautions that the latter two studies contained only "a small number of animals, and no control data" (10);

Thus, the B&P Document here has justified its Proposed Standards by citing only three older studies (1934-1949) describing only a few animals exposed to very high levels of HF. Positive effects were found only after prolonged and repeated exposure to HF at levels of 18.6-9784 ppm. By contrast, anticipated HF levels of <10 ppb near aluminum smelters are approximately 1,000 times less than the reported NOAEL for renal effects of 7 mg/m^3 (8.1 ppm) cited in these studies.

The B&P Document also states that HF exposures can result in

"nervous system changes such as learning problems". The Agency again fails to note the limitations of the studies cited and ATSDR's concerns about those studies:

- The ATSDR document cites a single Russian study that reported that HF inhalation affected conditioned responses and motor nerve response times (32). But, those results have not been confirmed or replicated in more than 30 years. In 1971, the National Academy of Sciences (NAS) stated that it was not possible to draw firm conclusions from this study because of the "absence of confirmatory replications" (9). That uncertainty remains today.

The B&P Document lists inhalation of HF and fluoride-containing dusts over several years as a risk for "skeletal fluorosis". But:

- ATSDR cites only reports of skeletal fluorosis due to high level occupational exposures and cites no example of fluorosis due to non-occupational inhalation exposure. ATSDR also states that "no studies were located regarding musculoskeletal effects in animals after inhalation exposure to fluoride" (10);
- The USPHS Review states: "For almost 40 years, investigators in the US have searched for evidence of skeletal fluorosis. Radiographic changes in bone indicative of skeletal fluorosis, changes in bone mass, and effects on skeletal maturation were not observed at water fluoride concentrations of 1.2 mg/L for 10 years and from 3.3 to 6.2

mg/L for a lifetime. In a survey of 170,000 radiographs of patients living in Texas and Oklahoma with water fluoride levels between 4 and 8 mg/L" only 23 cases of radiographic osteosclerosis, and no evidence of skeletal fluorosis, were found (11), p.46).

- Accordingly, it is not biologically plausible to suggest that the quantity of fluoride absorbed by inhalation at ambient levels of <10 ppb could lead to skeletal fluorosis.

The B&P Document cites inhalation of "large amounts" of HF as a potential cause of heart or lung injury. But:

- ATSDR cites reports of HF-induced lung injury in humans only after brief exposure to 100 mg/m^3 and after splash exposure to the face by concentrated HF (10);
- ATSDR cites lung effects in animals after exposure to 0.0152 mg/L (18.6 ppm), 6-7 hrs/day for about 35 days (31), but further noted that "this study is limited by the small number of animals used and the incomplete reporting of the data" (10);
- A second study reported lung injury after exposure to 24 mg/m^3, 6 hrs/day, 6 days/week for 30 days, but not after exposure to 7 mg/m^3 (19). As described above, the no effect level cited in that study is more than 1,000 times higher than the anticipated HF levels (e.g., <10 ppb) near aluminum smelters;
- ATSDR cites cardiac dysrhythmias in humans only after splash exposure to the face by concentrated HF;

- ATSDR cites a single study reporting myocardial injury after exposure of animals to "22.8 mg/m^3 [29 ppm] HF for an unspecified period" (30), but cautions that "the study was limited by the small sample size and undetermined exposure period" (10).

In other words, The B&P Document 's statements in Paragraph #2 misrepresent the factual content of the ATSDR Profile and are not relevant to routine emissions as contemplated in the Proposed Standards. Moreover, our literature review fails to find evidence that HF at the levels anticipated (e.g., <10 ppb) causes any of the human health effects described.

III.3 **Paragraph #3**: This paragraph describes three separate health effect issues. First, that "acute inhalation in combination with dermal exposure has resulted in pulmonary edema, pulmonary hemorrhagic edema and tracheobronchitis". This statement is factually correct, but not relevant to routine emissions as contemplated in the Proposed Standards. HF exposure levels actually reported to be associated with such lung injuries are at far higher exposure levels, as described above.

Second, the B&P Document indicates concern for an condition sometimes referred to as "pre-skeletal neighborhood fluorosis". In particular, the Agency describes a study that reported nausea and diarrhea in "a significant population (about 20 percent) exposed to airborne HF" (33). But:

- The B&P Document states that the study was of populations living "near an aluminum plant", but the actual published

study considered people living near an enamel smelter, not an aluminum plant;

- That report described no biological studies documenting increased exposure to fluorides or increased fluoride body burdens in the exposed population;
- This entity has been generally discredited. For example, the World Health Organization (WHO) has concluded: "No animal or laboratory studies have indicated the existence of fluoride allergy or fluoride intolerance, and no plausible mechanism for such allergic reactions has been suggested" (12) *p.88*).
- Likewise, NAS has written: "During the last few years, a number of reports have appeared in which fluoride is alleged to have been the agent responsible for a variety of vague and variable symptoms, such as headache, nausea, vomiting and epigastric pain. Most of these reports have come from a single investigator, GL Waldbott, who considers them to reflect an allergic response or an intolerance of fluoride. The problems associated with interpreting these reports have been reviewed ... if it exists, this condition has not yet been adequately documented" (9) p.199).
- Similarly, USPHS has concluded: "These symptoms are not believed to be caused by chronic intake of fluoride at any dose level, let alone at the low fluoride exposure levels cited by Waldbott. These findings have been dismissed" (11), p.69).

Finally, the B&P Document presents a list of conditions that might cause subsets of the population to be "unusually susceptible to the toxic effects of fluoride and its compounds". All of the examples cited might be relevant to either ingestion or occupational exposures. But, there is no evidence that such conditions would render people susceptible to adverse effects as a result of routine emissions as contemplated in the Proposed Standards.

III.4 **Paragraph #4**: This paragraph indicates that USEPA is reviewing the reference concentration assessment for HF.

- The current oral reference dose for fluoride is 6×10^{-2} mg/kg/day, corresponding to a fluoride water level of 1 mg/L (1 ppm) (10,22);

The Agency also states that "additional information on the health effects of HF and related gases can be found in the literature review contained" in USEPA's 1988 Summary Review of Health Effects (22). But:

- That Summary Review states that chronic exposure to low concentrations "in the context of occupational exposure" may cause irritation of the respiratory tract, but "most other manifestations of chronic fluoride toxicity are dependent solely on the intake of fluoride ion independent of the source or route of exposure" (22);
- The Summary Review also indicates that effects of chronic fluoride exposures in humans "have been reported occasionally ... [but] ... None of these effects has been

convincingly established, particularly for fluoride concentrations likely to be encountered by the general public" (22).

Thus, this paragraph and the cited USEPA Summary Review are not relevant to routine emissions as contemplated in the Proposed Standards.

III.5 Summary: Review of the relevant sections of USEPA's Basis and Purpose Document indicates no information on human health effects relevant to the types of routine fluoride emissions contemplated in the Proposed Standards.

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